Coupling In Situ and Satellite Data to Validate Satellite Optical Properties

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I. ABSTRACT

Methods for validating satellite optical algorithms in coastal waters have improved over the past few years. Optical properties in coastal waters change rapidly on very fine temporal and spatial scales. It is therefore inappropriate to validate satellite optical algorithms at large spatial scales using insitu point measurements due to the variation within the large spatial areas. The variation within the satellite region (1*km) must be accounted for in the comparison with the point measurement. Inherent Optical Properties (absorption and scattering coefficients) were derived and validated from SeaWIFS imagery covering the Mississippi Bight and Northern Adriatic regions for coastal(turbid) and open-ocean (blue) waters. We examine the optical variability over small spatial scales (100, 250, 500, & 1000m) using continuous underway ship measurements bin averaged and over large scales (5, 10, & 20 km) using SeaWIFS imagery. We examined the changes to the mean to variance relationships at the various spatial scales. We show results from a validation using 1 kilometer binned underway ship measurements of absorption and scattering coefficients with derived SeaWIFS properties from three different algorithms (1 kilometer).

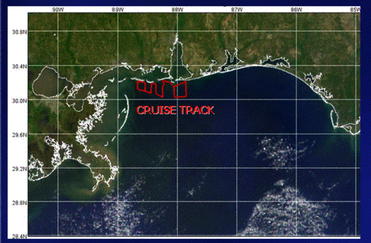
II. OBJECTIVES

1. Examine optical variability (absorption and scattering coefficients) over small spatial scales (meters) using continuous underway ship measurements for the Mississippi Bight and Northern Adriatic.
2. Examine optical variability (absorption and scattering coefficients) over larger spatial scales (kilometers) using SeaWIFS imagery for the Mississippi Bight and Northern Adriatic.
3. Examine the mean to variance relationships associated with changing spatial scales (100 meters – 20 kilometers).
4. Compare 1 kilometer binned underway ship measurements of absorption and scattering coefficients to same SeaWIFS properties derived from three separate algorithms (Arnone et.al "Under Evaluation", Carder et.al 1997, Lee et.al 2002) to assess the accuracy of satellite retrievals (validation).

III. REGIONS OF INTEREST & INSITU DATA INFO

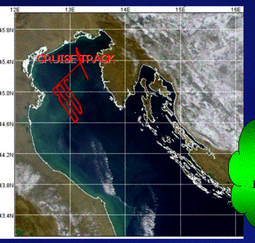
SEAWIFS @ 1KM

MISSISSIPPI BIGHT



8,040 Continuous Underway Samples
Absorption Range 0.20 - 1.7
Scattering Range 0.01 - 6.2

NORTHERN ADRIATIC



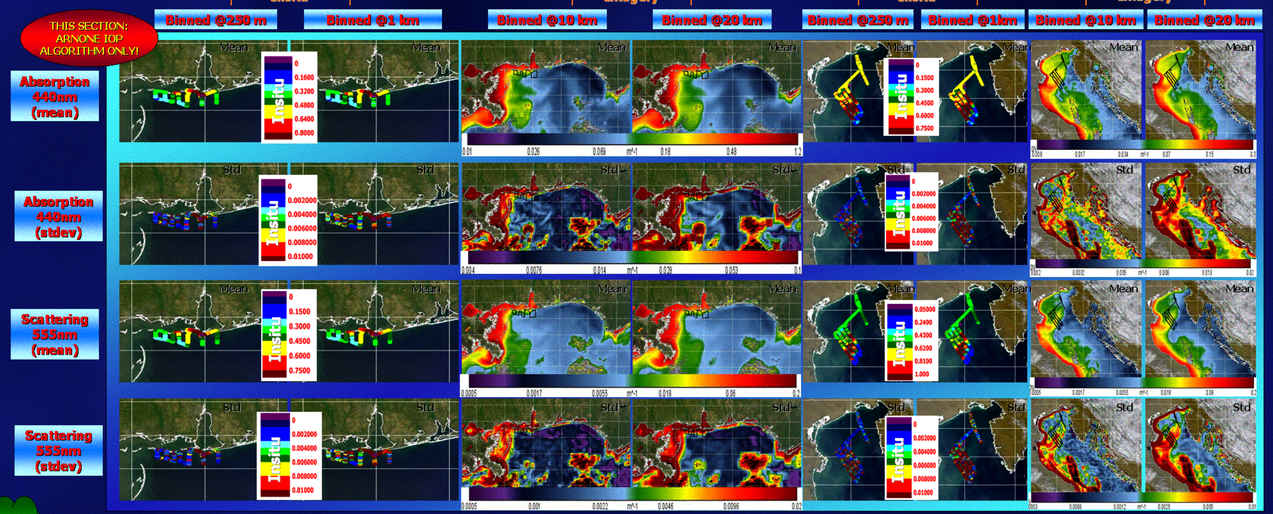
4,700 Continuous Underway Samples
Absorption Range 0.20 - 1.7
Scattering Range 0.01 - 6.2

INSITU DATA

Absorption [a] and Beam Attenuation [c] Coefficients were measured continuously along the cruise tracks shown above using a WetLabs ac9 at 9 wavelengths (412 440 488 510 532 555 676 715nm) at a depth of 2-3 meters below the surface. The instruments were calibrated using milli-Q water, scatter correction (Zaneveld et al. 1994) and pure water correction (Pope & Fry 1997) was applied. The Scattering Coefficients were derived by difference (c-a). Note: The wavelengths highlighted in red were ones observed in this analysis.

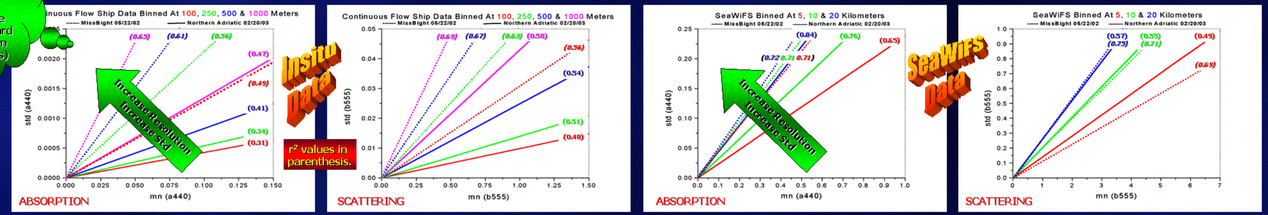
IV. OPTICAL VARIABILITY OVER VARIOUS SPATIAL SCALES W/ STANDARD DEVIATION TO MEAN RELATIONSHIPS

THIS SECTION: ARNONE IOP ALGORITHM ONLY!



Increase in Resolution Yields Increase in Standard Deviation (All Plots)

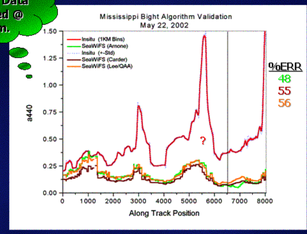
Mississippi Bight — Northern Adriatic

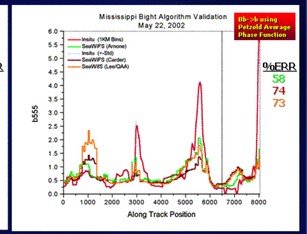


NOTE: The Mean absorption and scattering coefficients are similar with increasing bin size (coarser image resolution). The standard deviation increases as the bin size increases. In the plots, the r^2 increases with an increase in bin size. The std to mean relationships between the two regions are different for absorption and scattering. Hence, it is less of a difference for the coarser spatial resolutions (5, 10, 20 km).

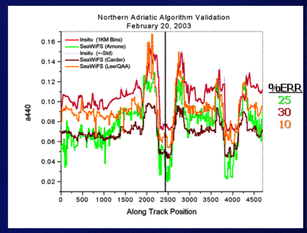
V. OPTICAL PROPERTY ALGORITHM VALIDATION

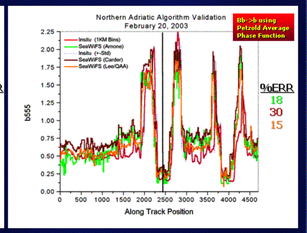
Insitu Data Binned @ 1km.





NOTE: The measured absorption is higher than the derived values (Possibly due to a problem with the sensor for this survey only). The measured scattering values are affected by the absorption values (b=c-a). In both cases, the features match well.





NOTE: In both cases, the features are well matched along with the optical intensities derived from SeaWIFS for the Northern Adriatic. The QAA algorithm (Lee et al. 2002) overall produced better estimates of the optical properties(10 & 15 % for a440 and b555).

VI. SUMMARY

- The variability of absorption and scattering binned over different spatial resolutions ranging from 100m–20km behaved similarly (increased) with an increase in bin size (coarser resolution) while the means remained somewhat constant.
- The stdev to mean relationships from both regions had a gradual increase in ratio as the bin size was increased (the coarser the image resolution the higher the standard deviation).
- The r2 values from the stdev to mean relationships increased also with increasing bin size.
- The validation results were quite promising especially for the satellite derived values in the Northern Adriatic. The Quasi-Analytical algorithm developed by Lee et al. 2002 yielded better estimates of the optical properties in the Northern Adriatic while the Arnone et al. algorithm yielded slightly better results for the Mississippi Bight region.

REFERENCES

K.L. Carder, F.-R. Chen, and J.P. Cannizzaro, MODIS Ocean Science Team Algorithm Theoretical Basis Document: Case II Chlorophyll-a, ATBD-19, Version 6, 30 June 2002.

Z.P. Lee, K.L. Carder, and R.A. Arnone, "Deriving inherent optical properties from water color: a multiband quasi-analytical algorithm for optically Deep waters," Appl. Optics Vol. 41 (#27), pp.5755-5772 (2002).

R.M. Pope and E. S. Fry, "Absorption spectrum (380-700nm) o pure water. II. Integrating cavity measurements," Appl. Optics, Vol.36 (#33), pp. 8710-8723 (1997).

J.R.V. Zaneveld, J.C. Kitchen, and C. Moore, "The scattering error correction of reflecting-tube absorption meters," Ocean Optics XII Proceedings Of SPIE, 2258, pp.44-55 (1994).